HERPETOLOGICAL SURVEY IN THE NORTHERN RANGE OF YELLOWSTONE NATIONAL PARK

ANNUAL REPORT TO

YELLOWSTONE NATIONAL PARK

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INTRODUCTION

A systematic survey of amphibians and reptiles in the north central part of Yellowstone National Park was initiated for two reasons. First, a survey of modern herps near Lamar Cave would provide information on current associations of different species with specific habitats. Since herps are sensitive indicators of climate and habitat, such a survey would allow interpretations of past climates and habitats based on the record of herpetological remains excavated from the floor of Lamar Cave. There is no evidence that Lamar Cave was used by early Americans, and the bones probably were collected by wood rats and mammalian and avian predators (Hadley 1990).

The second reason for a systematic, repeatable survey of amphibians was that it would serve as baseline data against which future surveys might be compared to determine if amphibian populations in Yellowstone are declining. Some populations of amphibians have been undergoing worldwide declines since the 1970's (Milstein 1990, Wake 1991), including some species of frogs and toads in the western United States (Corn and Fogleman 1984, Wyman 1990, Hayes and Jennings 1986). A strong argument can be made that amphibians are likely to be very susceptible to human-produced pollutants and to climatic changes because of their thin, specialized skin and variable body temperatures that reflect environmental temperatures. Furthermore, since they inhabit both aquatic and terrestrial ecosystems, they can be indicators of the health of both types of environments. Amphibian declines also represent a potentially significant loss in biodiversity, as they are important parts of aquatic and terrestrial food webs. They are major consumers of invertebrates and in turn provide a significant prey base for birds, mammals, and reptiles (Martin 1990, Ross 1991) because of their high efficiencies of biomass conversion (Pough 1983). Maintenance of amphibian biodiversity is likely to be critical, therefore, in maintaining many ecosystems as we now know them.

Yellowstone National Park is relatively undisturbed and distant from large population centers and may provide significant insights to testing hypothesized causes of declines of amphibians (Koch and Peterson 1989). Furthermore, there is some existing baseline information on amphibian populations in Yellowstone (Turner 1955, 1959, 1960, and Fishery and Aquatic Management Program in Yellowstone National Park - Technical Reports for Calendar Years 1964-1982) as well as a current monitoring program that is being carried out by C. Peterson of Idaho State University. This study would make significant additions to the existing baseline data.

OBJECTIVES OF THE STUDY

The objectives of the study were to survey sites in the area near Lamar Cave:

1) to determine which of the potential amphibian and reptile species were present, and

2) to briefly describe the habitat affinities of these amphibians and reptiles species.

METHODS

Species of Interest

Previous surveys of reptiles and amphibians in Yellowstone National Park suggested that the species that would likely be encountered around aquatic sites would be: *Ambystoma tigrinum*, the tiger salamander; *Bufo boreas*, the western toad; *Pseudacris triseriata*, the striped chorus frog; *Rana pretiosa*, the spotted frog; *Thamnophis elegans*, the wandering garter snake. Other species that are less dependent on aquatic sites, such as the bullsnake *Pituophis melanoleucus*, the rubber boa *Charina bottae*, and the sagebrush lizard *Sceloporus graciosus* were not observed in this survey.

Study Sites

In 1992 forty-eight sites that contained standing water for at least part of the year were selected within the sagebrush-grassland environment of Yellowstone's Northern Range to be surveyed for the presence or absence of amphibian and reptile species. Forty-four of the sites were located in the vicinity of the Lamar Cave between Junction Butte and the Slough Creek Road and ranged in nature from small ephemeral pools to large permanent bodies of water (Fig. 1). The remaining four sites were larger, permanent bodies of water located further from the cave: Slide Lake (Fig. 2, site #45), two unnamed lakes on Mt. Everts referred to by the Fishery and Aquatic Management Program in Yellowstone National Park as SONYEW #0899 and SONYEW #0897 (Fig. 2, site #47 and site #48, respectively), and Foster Lake (Fig. 3, site#46).

The physical characteristics of each of the forty eight sites were described during the 1992 and/or 1993 field seasons. Characteristics recorded included a visual estimate of the percent of the water surface that was covered by emergent vegetation on the day the site was visited (measured in 1992 only), maximum depth on the day the site was visited (measured in both 1992 and 1993), and an estimate of the area (measured in 1992 only). The dates of drying were also recorded for those pools that dried up in 1992 or 1993. The coordinates (latitude and

longitude) and general descriptions of each site, and dates of drying of sites, are in the Appendix.

Techniques

Determining which species of amphibians and reptiles were present at a particular site required that the site be repeatedly surveyed. A site was considered "surveyed" when it was merely visited, when its periphery was carefully searched from the shore, or when it was searched by wading into the water while wearing chest waders. Each site was surveyed at least twice during the 1992 field season (mid-June through mid-August), once to search its periphery and once to search it by wading. (It should be noted that site #45 and site #36 were surveyed weekly or biweekly by me throughout the 1992 and 1993 field seasons as part of a long term amphibian monitoring project conducted by C. Peterson of Idaho State University). In 1993 every site was visited (i.e., the site was approached but not searched) at least once during the months of April and May. The purpose of visiting the site was to listen for calling *P. triseriata*, whose chorus strength seemed to be at a peak during these months. Every site also had its periphery searched at least twice during the months of April through July of 1993. (When peripheral searches were conducted on sites with little standing water, such as swales and wet meadows, a zig-zagging search pattern was used to more thoroughly survey the site). These peripheral searches, when conducted during late spring and early summer (before the aquatic vegetation began to inhibit the observability of the species), were very effective at yielding observations of *A. tigrinum* and *R. pretiosa* larvae and metamorphs. When conducted in mid-summer during the morning hours, these searches were effective at yielding *T. elegans* observations. Furthermore, every site was searched at least once by me while wading into the water in chest waders during the months of April through July of 1993. Wading searches, when conducted during late spring and early summer, were effective at yielding observations of *A. tigrinum* and *R. pretiosa* eggs.

In addition to the direct survey method utilized to detect the presence of a species, the indirect method of live trapping with minnow traps was also employed. Minnow traps have been successfully used in past surveys to detect the presence of *A. tigrinum* larvae and metamorphs (Carpenter 1953). The method was used in this study to detect *A. tigrinum* where its presence was in no other way indicated. Several different trapping schemes utilizing minnow traps were tried throughout the 1992 field season to determine the most effective approach, including trap sets at different depths and the use of bait. These traps were most effective when set unbaited about six meters from shore, and left overnight. Bait (beef liver) attracted amphibian predators such as diving beetles

(*Dytiscus*) and leeches but did not seem to affect the number of salamanders captured. Three minnow traps were set for one night at each site where the presence of *A. tigrinum* was not detected by other means. This method proved to be the most effective at detecting the species as well.

A species was considered present at a site if and only if its vocalization was heard, a direct observation of an adult, larva, or egg of the species was made, or if the species was trapped in a minnow trap. Anecdotal evidence or observations by another individual were not included.

RESULTS

Distribution and Habitat Affinities

Data collected during the 1992 and 1993 field seasons with respect to the presence or absence of amphibian and reptile species at the forty-eight survey sites were combined for the final analysis. At least one of the five herp species was observed in forty-three of the forty-eight sites (90%)(Table 1). *A. tigrinum* was the most widely distributed species, having been observed in thirty-one of the forty-eight sites (65%). *R. pretiosa* was observed in twenty-two sites (46%). *P. triseriata* was observed in nineteen sites (40%). *T. elegans* was observed in fifteen sites (31%). *B. boreas* was observed in three sites (6%).

Repeat observations of *A. tigrinum* at the same site in both 1992 and 1993 occurred in twelve of the thirteen (92%) sites with the potential for subsequent observation (i.e., *A. tigrinum* was only observed in thirteen of the forty-eight sites in 1992). Repeat observations of *R. pretiosa* occurred in all fifteen (100%) of the sites with the potential for subsequent observation. Repeat observations of *T. elegans* occurred in seven of the eleven (64%) sites with the potential for subsequent observation. Repeat observations of *P. triseriata* occurred in all three (100%) of the sites with the potential for subsequent observation. *B. boreas* was not observed in 1992. These results are not meant to indicate an increase in species observations from 1992 to 1993. The 1992 field season was abbreviated (the period from mid-June through mid-August only). Thus many of the sites were visited late in the season and it is very likely that many individuals had dispersed from the sites or were less active within the sites. Many of the sites were also visited infrequently, therefore allowing extrinsic factors such as climate to influence the observations.

During the course of the 1992 and 1993 field seasons basic biotic and abiotic characteristics were recorded for each of the forty-eight sites (Table 1). The maximum depth of the water at the site was measured in both 1992

and 1993, with the measurements shown in Table 1 being from 1993. The area and amount of emergent vegetation at each site were estimated in 1992 only. Analysis of species occurrence with respect to most of these characteristics (Tables 2-4) shows that we may expect to find all five species of herps in sites that are larger than one acre in size, with greater than 70% emergent vegetation, and ephemeral in nature. However, this assessment may be influenced by the low number of observations of *B. boreas*. Excluding *B. boreas* from the analysis of species occurrence with respect to these characteristics shows that we may expect to find the remaining four species of herps in sites of any size (within the range of sizes surveyed), with any amount of emergent vegetation, and that are either permanent or ephemeral in nature. Sites larger than five acres, with between 30% and 70% emergent vegetation, and permanent in nature had the highest mean number of species per site.

A t-test for small sample sizes was used to determine whether differences existed between those sites with and those sites without a particular species of herp with respect to the mean values of the measured habitat characteristics. Sites where *A. tigrinum* was observed were significantly ($P \leq .05$) deeper than sites where *A. tigrinum* was not observed (Table 5). There was no significant difference between sites with and without *A. tigrinum* with respect to surface area, percent emergent vegetation, or elevation.

Analysis of the characteristics measured at each site showed no significant difference ($P \leq .05$) between sites with and without *B. boreas* (Table 6).

Sites where *P. triseriata* was observed had significantly ($P \leq .05$) greater percentages of emergent vegetation than sites where *P. triseriata* was not observed (Table 7). There was no significant difference between sites with and without *P. triseriata* with respect to surface area, depth, or elevation.

Sites where *R. pretiosa* was observed were significantly ($P \leq .05$) deeper than sites where *R. pretiosa* was not observed (Table 8). There was no significant difference between sites with and without *R. pretiosa* with respect to surface area, percent emergent vegetation, or elevation.

Sites where *T. elegans* was observed had significantly ($P \leq .05$) larger surface areas than sites where *T. elegans* was not observed (Table 9). There was no significant difference between sites with and without *T. elegans* with respect to depth, percent emergent vegetation, or elevation.

Sites where one or more of the herp species was observed had significantly ($P \leq .05$) greater percentages of emergent vegetation than sites where herps were not observed (Table 10). There was no significant difference between sites with and without herps with respect to

surface area, depth, or elevation.

Because these are results from two field seasons only, it is impossible to account for the presence or absence of species at various sites due to natural population fluctuations. Only long term, intensive studies on one or a few populations can demonstrate this phenomenon (Pechmann et al., 1991). The results of this survey indicate that A. tigrinum, P. triseriata, R. pretiosa, and T. elegans could potentially be found at sites of any size, with any amount of emergent vegetation, and either permanent or ephemeral in nature, and thus there are likely to be other more cryptic factors which influence the presence or absence of these species. The fact that the species surveyed are well distributed across not only the northern range but much of the Rocky Mountains indicates that their presence at a particular locale may not be due to the existence of any vegetational or climatic zone, but rather to the presence of water. Indeed, the observations of reptiles and amphibians in this survey were invariably made in close proximity to water. From this we can predict that these particular species of herps would be more widely distributed during wetter times, and that they could therefore be used as indicators of the amount of surface water in existence.

Table 1. Characteristics of study sites. (Area and emergent vegetation estimates were made in 1992).

Site No.	Approx. Max. Area (Acres)	Max. Depth[1] (cm)	Percent Emerg. Veget.	Elev. (Feet)	Perm. or Ephem.[2]	Species Present[3] RP	AT	TE	PT	BB
1	1.5	80+ (4/27)	50	6240	P		2	B	3	
2	3.4	51 (5/21)	99	6280	E			B	3	
3	.5	80+ (5/23)	95	6280	E		B	3		
4	3.5	80+ (4/27)	90	6280	E		3			
5	5.3	80+ (4/27)	<30	6220	P		B	B	3	
6	3.2	65 (5/22)	100	6200	E		3		B	3
7	2.4	30 (5/22)	100	6200	E			2		
8	.4	47 (5/22)	100	6160	E		3			
9	.4	29 (5/22)	100	6200	E		3			
10	1.3	40 (5/22)	99	6160	E		3			
11	1.9	75 (5/21)	100	6220	E		3		3	
12	10	3m (1977)	<30	6120	P		3			
13	26.5	3m (1977)	<30	6120	P		B			
14	6.9	80+ (4/27)	<30	6200	P		3	B	3	
15	.7	75 (5/13)	100	6160	E	3			3	
16	.6	32 (5/13)	100	6160	E				3	
17	1.1	80+ (5/13)	80	6180	E	3	3			3
18	.2	51 (5/13)	100	6160	E		3		3	
19	1.2	67 (5/13)	100	6160	E		3		3	
20	.2	0 (4/27)	0	6200	E					
21	.1	0 (4/27)	0	6200	E					
22	.04	0 (4/27)	0	6200	E					
23	.7	46 (5/21)	100	6200	E		3			
24	.4	45 (5/21)	100	6200	E	3	3		3	
25	3.1	55 (5/13)	99	6200	E	B	B	2	B	
26	19.5	80+ (5/13)	95	6200	E	B	B	3	3	3
27	4.3	80+ (5/27)	99	6160	E	B				
28	1.5	17 (5/27)	100	6160	E	B				
29	6.3	70 (5/27)	99	6160	E	B				
30	1.7	38 (5/27)	100	6200	E					
31	5.4	16 (5/13)	99	6220	E	3				
32	1.3	15 (5/13)	100	6360	E					
33	3.0	80+ (5/14)	<30	6200	P		3			
34	2.7	80+ (5/14)	<30	6200	P		3			
35	1.0	39 (5/13)	100	6200	E		3			
36	7.0	80+ (5/12)	90	6200	E	B	B	3	B	
37	2.1	42 (5/12)	100	6200	E	B	B	2	3	
38	3.0	80+ (5/12)	70	6200	E	B	3			
39	7.2	80+ (5/14)	60	6200	P	B		3	3	
40	3.3	80+ (5/14)	10	6200	P	B		2		
41	4.6	80+ (5/14)	70	6200	P	B	B		3	
42	.6	52 (5/14)	100	6220	E	B			3	
43	.9	50 (5/12)	100	6200	E	3	3		3	
44	4.6	61 (5/12)	100	6240	E	B				
45	5.0	5m (1974)	<30	5680	P	B	B	B		
46	8.0	6m (1974)	<30	6620	P	B	B	B		
47	23.0	8m (1976)	<30	7273	P	3	B	B		
48	12.0	8m (1976)	60	7253	P	3	B			

[1] Number in () indicates measurement date (1993 unless indicated).
[2] P= site likely to be permanent in most years; E= site likely to be ephemeral in some years.
[3] RP= *Rana pretiosa*; AT= *Ambystoma tigrinum*; TE= *Thamnophis elegans*; PT= *Pseudacris triseriata*; BB= *Bufo boreas*; 2= observed in 1992 only; 3= observed in 1993 only; B= observed both years.

Table 2. Percent occurrence of species in three size classes of sites (ponds). n equals the number of sites sampled; the numbers in () indicate the number of sampled sites in which that species occurred.

Species	<1 acre n=13	1-5 acres n=23	>5 acres n=12
Ambystoma tigrinum	53.8 (7)	65.2 (15)	75.0 (9)
Bufo boreas	---	8.7 (2)	8.3 (1)
Pseudacris triseriata	46.2 (6)	34.8 (8)	41.7 (5)
Rana pretiosa	30.8 (4)	43.5 (10)	66.7 (8)
Thamnophis elegans	7.7 (1)	30.4 (7)	58.3 (7)
Total number of spp.	4	5	5
Mean number of spp./site	1.4	1.8	2.5

Table 3. Percent occurrence of species with respect to percentage of water surface covered by emergent vegetation. n equals the number of sites sampled; the numbers in () indicate the number of sampled sites in which that species occurred.

Species	<30% n=13	30-70% n=5	>70% n=30
Ambystoma tigrinum	69.2 (9)	80.0 (4)	60.0 (18)
Bufo boreas	---	---	10.0 (3)
Pseudacris triseriata	15.4 (2)	60.0 (3)	46.7 (14)
Rana pretiosa	30.8 (4)	80.0 (4)	46.7 (14)
Thamnophis elegans	46.2 (6)	40.0 (2)	23.3 (7)
Total number of spp.	4	4	5
Mean number of spp./site	1.6	2.6	1.9

Table 4. Percent occurrence of species with respect to the permanency of water at the site. n equals the number of sites sampled; the numbers in () indicate the number of sampled sites in which that species occurred.

Species	Permanent n=14	Ephemeral n=34
Ambystoma tigrinum	85.7 (12)	55.9 (19)
Bufo boreas	---	8.8 (3)
Pseudacris triseriata	35.7 (5)	41.2 (14)
Rana pretiosa	50.0 (7)	44.1 (15)
Thamnophis elegans	57.1 (8)	20.6 (7)
Total number of spp.	4	5
Mean number of spp./site	2.3	1.7

Table 5. Comparison of habitat variables measured on sites with and without *Ambystoma tigrinum*. Significance is based on t-test. Numbers shown are mean ± standard deviation with range in ().

Characteristic	Sites (n=31) with AT	Sites (n=17) without AT	Significance ($P \leq .05$)
Area (acres)	5.2 ± 6.7 (0.2,26.5)	2.6 ± 2.3 (0.04,7.2)	NS
Depth (cm)	158.4 ± 216.3 (29,800)	41.0 ± 29.9 (0,80)	S
% Emerg. Veg.	73.2 ± 30.7 (30,100)	74.5 ± 42.3 (0,100)	NS
Elevation	6262.8 ± 295.5 (5680,7273)	6208.2 ± 51.0 (6160,6360)	NS

Table 6. Comparison of habitat variables measured on sites with and without *Bufo boreas*. Significance is based on t-test. Numbers shown are mean ± standard deviation with range in ().

Characteristic	Sites (n=3) with BB	Sites (n=45) without BB	Significance ($P \leq .05$)
Area (acres)	7.9 ± 10.1 (1.1,19.5)	4.0 ± 5.3 (0.04,26.5)	NS
Depth (cm)	75.0 ± 8.7 (65,80)	119.6 ± 188.5 (0,800)	NS
% Emerg. Veg.	91.7 ± 10.4 (80,100)	72.4 ± 35.6 (0,100)	NS
Elevation	6193.3 ± 11.5 (6180,6200)	6246.8 ± 247.1 (5680,7273)	NS

Table 7. Comparison of habitat variables measured on sites with and without *Pseudacris triseriata*. Significance is based on t-test. Numbers shown are mean ± standard deviation with range in ().

Characteristic	Sites (n=19) with PT	Sites (n=29) without PT	Significance ($P \leq .05$)
Area (acres)	3.7 ± 4.5 (0.2,19.5)	4.6 ± 6.3 (0.04,26.5)	NS
Depth (cm)	64.2 ± 16.1 (32,80)	151.3 ± 229.7 (0,800)	NS
% Emerg. Veg.	85.4 ± 24.6 (30,100)	65.9 ± 38.6 (0,100)	S
Elevation	6202.1 ± 29.7 (6160,6280)	6270.6 ± 306.2 (5680,7273)	NS

Table 8. Comparison of habitat variables measured on sites with and without *Rana pretiosa*. Significance is based on t-test. Numbers shown are mean ± standard deviation with range in ().

Characteristic	Sites (n=22) with RP	Sites (n=26) without RP	Significance ($P \leq .05$)
Area (acres)	5.6 ± 5.8 (0.4,23.0)	3.1 ± 5.3 (0.04,26.5)	NS
Depth (cm)	173.8 ± 249.2 (16,800)	68.7 ± 73.1 (0,300)	S
% Emerg. Veg.	78.2 ± 29.2 (10,100)	69.7 ± 39.1 (0,100)	NS
Elevation	6287.5 ± 348.3 (5680,7273)	6204.6 ± 51.9 (6120,6360)	NS

Table 9. Comparison of habitat variables measured on sites with and without *Thamnophis elegans*. Significance is based on t-test. Numbers shown are mean ± standard deviation with range in ().

Characteristic	Sites (n=15) with TE	Sites (n=33) without TE	Significance ($P \leq .05$)
Area (acres)	6.5 ± 6.4 (0.5,23.0)	3.2 ± 5.0 (0.04,26.5)	S
Depth (cm)	181.2 ± 241.6 (30,800)	87.6 ± 143.8 (0,800)	NS
% Emerg. Veg.	63.2 ± 34.4 (10,100)	78.4 ± 34.5 (0,100)	NS
Elevation	6282.2 ± 328.7 (5680,7273)	6225.8 ± 189.5 (6120,7253)	NS

Table 10. Comparison of habitat variables measured on sites with and without herps. Significance is based on t-test. Numbers shown are mean ± standard deviation with range in ().

Characteristic	Sites (n=43) with herps	Sites (n=5) without herps	Significance ($P \leq .05$)
Area (acres)	4.7 ± 5.8 (0.2,26.5)	0.7 ± 0.8 (0.04,1.7)	NS
Depth (cm)	129.2 ± 189.3 (16,800)	10.6 ± 16.6 (0,38)	NS
% Emerg. Veg.	77.5 ± 30.3 (10,100)	40.0 ± 54.8 (0,100)	S
Elevation	6244.8 ± 252.3 (5680,7273)	6232.0 ± 71.6 (6200,6360)	NS

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APPENDIX

Survey Site Descriptions

#1: 44.915N, 110.396W Deep glacial pothole; organic muck substrate; shoreline vegetation well established.

#2: 44.914N, 110.392W Marsh of moderate depth; organic muck substrate.

#3: 44.914N, 110.391W Deep glacial pothole; organic muck substrate; shoreline vegetation well established.

#4: 44.912N, 110.389W Deep glacial pothole; organic muck substrate; shoreline vegetation well established.

#5: 44.913N, 110.384W Deep glacial pothole; organic muck substrate; shoreline vegetation well established.

#6: 44.921N, 110.386W Marsh with an area of moderately deep water; organic muck substrate.

#7: 44.921N, 110.384W Swale with an area of moderately deep water; organic muck and spongy "bog type" substrates; channel of slow moving water.

#8: 44.921N, 110.383W Pool of moderate depth; organic muck substrate.

#9: 44.913N, 110.382W Marsh with an area of moderately deep water; organic muck substrate.

#10: 44.914N, 110.380W Large swale with several shallow pools; swale has spongy "bog type" substrate, pools have organic muck substrate.

#11: 44.911N, 110.371W Pool of moderate depth; organic muck substrate; shoreline vegetation well developed.

#12: 44.917N, 110.373W Deep glacial pothole lake; organic muck substrate; moderate shoreline vegetation development; AKA Little Trumpeter Lake.

#13: 44.916N, 110.367W Deep glacial pothole lake; organic muck substrate; moderate shoreline development; broad, thick algal mats along shore; AKA Trumpeter Lake.

#14: 44.909N, 110.362W Deep glacial pothole lake; organic muck substrate; shoreline vegetation well developed.

#15: 44.912N, 110.361W Pool of moderate depth; organic muck substrate; shoreline vegetation well developed.

#16: 44.911N, 110.360W Pool of moderate depth; organic muck substrate; shoreline vegetation well developed.

#17: 44.910N, 110.357W Deep glacial pothole lake; organic muck substrate; shoreline vegetation well developed.

#18: 44.910N, 110.356W Wet meadow with a shallow pool; organic muck substrate.

#19: 44.909N, 110.354W Pool of moderate depth; solid "sod type" substrate; shoreline vegetation well developed.

#20: 44.910N, 110.368W "Bison wallow"; very trampled organic muck substrate; very shallow, usually dry except after rain; dry at first visit in 1992 (27 July) and 1993 (mid-May).

#21: 44.910N, 110.368W "Bison wallow"; very trampled organic muck substrate; very shallow, usually dry except after rain; dry at first visit in 1992 (27 July) and 1993 (mid-May).

#22: 44.910N, 110.369W "Bison wallow"; very trampled organic muck substrate; very shallow, usually dry except after rain; dry at first visit in 1992 (27 July) and 1993 (mid-May).

#23: 44.912N, 110.368W Wet meadow with pool of moderate depth; organic muck substrate.

#24: 44.910N, 110.364W Wet meadow with shallow pool; organic muck substrate.

#25: 44.911N, 110.348W Pool of moderate depth; organic muck substrate; shoreline vegetation well developed; dry 3 August, 1993.

#26: 44.913N, 110.349W Large, deep pool; organic muck substrate; shoreline vegetation well developed.

#27: 44.912N, 110.347W Swale with several pools; swale has spongy "bog type" substrate, pools have organic muck substrate; site is spring fed; pool from which spring originates is 80 cm deep, but lower 40 cm is very fine silt.

#28: 44.914N, 110.347W Wet meadow with an area of moderately deep water; organic muck and spongy "bog type" substrate; site may be spring fed.

#29: 44.911N, 110.346W Swale with semi-subterranean stream running through it; stream surfaces in small, very deep pools with organic muck substrates; swale has spongy "bog type" substrate; stream originates in site #30.

#30: 44.908N, 110.342W Swale with one shallow pool; swale has spongy "bog type" substrate, pool has organic muck substrate; site may be spring fed.

#31: 44.906N, 110.343W Swale with several small pools;swale has spongy "bog type" substrate, pool has organic muck substrate.

#32: 44.901N, 110.315W Swale in aspen grove with several small, shallow pools; swale has spongy "bog type" substrate, pools have organic muck substrate.

#33: 44.918N, 110.340W Pool of very turbid water; sandy and organic muck substrates; poor shoreline vegetation development, as shoreline was well trampled by elk and bison.

#34: 44.920N, 110.341W Pool of very turbid water; sandy and organic muck substrates; poor shoreline vegetation development, as shoreline was well trampled by elk and bison.

#35: 44.922N, 110.339W Shallow pool with organic muck substrate; shoreline vegetation well developed; dry May 1992 but subsequently refilled.

#36: 44.931N, 110.313W Deep glacial pothole; organic muck substrate; shoreline vegetation well developed; AKA Slough Creek Pond, part of C. Peterson's monitoring project.

#37: 44.934N, 110.313W Glacial pothole of moderate depth; organic muck substrate; shoreline vegetation well developed; dry 27 August, 1993.

#38: 44.930N, 110.316W Deep glacial pothole; organic muck substrate; shoreline vegetation well developed.

#39: 44.927N, 110.318W Pool is an oxbow of Slough Creek; organic muck substrate; shoreline vegetation well developed; flooded by Slough Creek during high water times.

#40: 44.926N, 110.322W Pool is an oxbow of Slough Creek with an open channel to Slough Creek; organic muck substrate; steep banks with moderate vegetation development.

#41: 44.924N, 110.321W Pool is an oxbow of Slough Creek; organic muck substrate; flooded by Slough Creek during high water times.

#42: 44.937N, 110.313W Pool of moderate depth; organic muck and solid "sod type" substrates; well developed shoreline vegetation; flooded by Slough Creek during high water in 1993.

#43: 44.938N, 110.312W Pool of moderate depth; organic muck substrate; well developed shoreline vegetation.

#44: 44.943N, 110.309W Large pool of moderate depth; organic muck substrate; well developed shoreline vegetation.

#45: 45.003N, 110.699W Large lake near Mammoth; organic muck substrate; well developed shoreline vegetation; AKA Slide Lake, part of C. Peterson's monitoring project.

#46: 44.873N, 110.167W Large lake in Lamar Valley; organic muck substrate; well developed shoreline vegetation; AKA Foster Lake.

#47: 44.960N, 110.624W Large lake on Mount Everts; rocky and organic muck substrate; moderate shoreline vegetation development; AKA Everts #0899, in USFWS Fishery and Aquatic Management Program-- Technical Reports for Calendar Years 1964-1982.

#48: 44.973N, 110.628W Large lake on Mount Everts; organic muck substrate; shoreline vegetation well developed; AKA Everts #0897, in USFWS Fishery and Aquatic Management Program-- Technical Reports for Calendar Years 1964-1982.

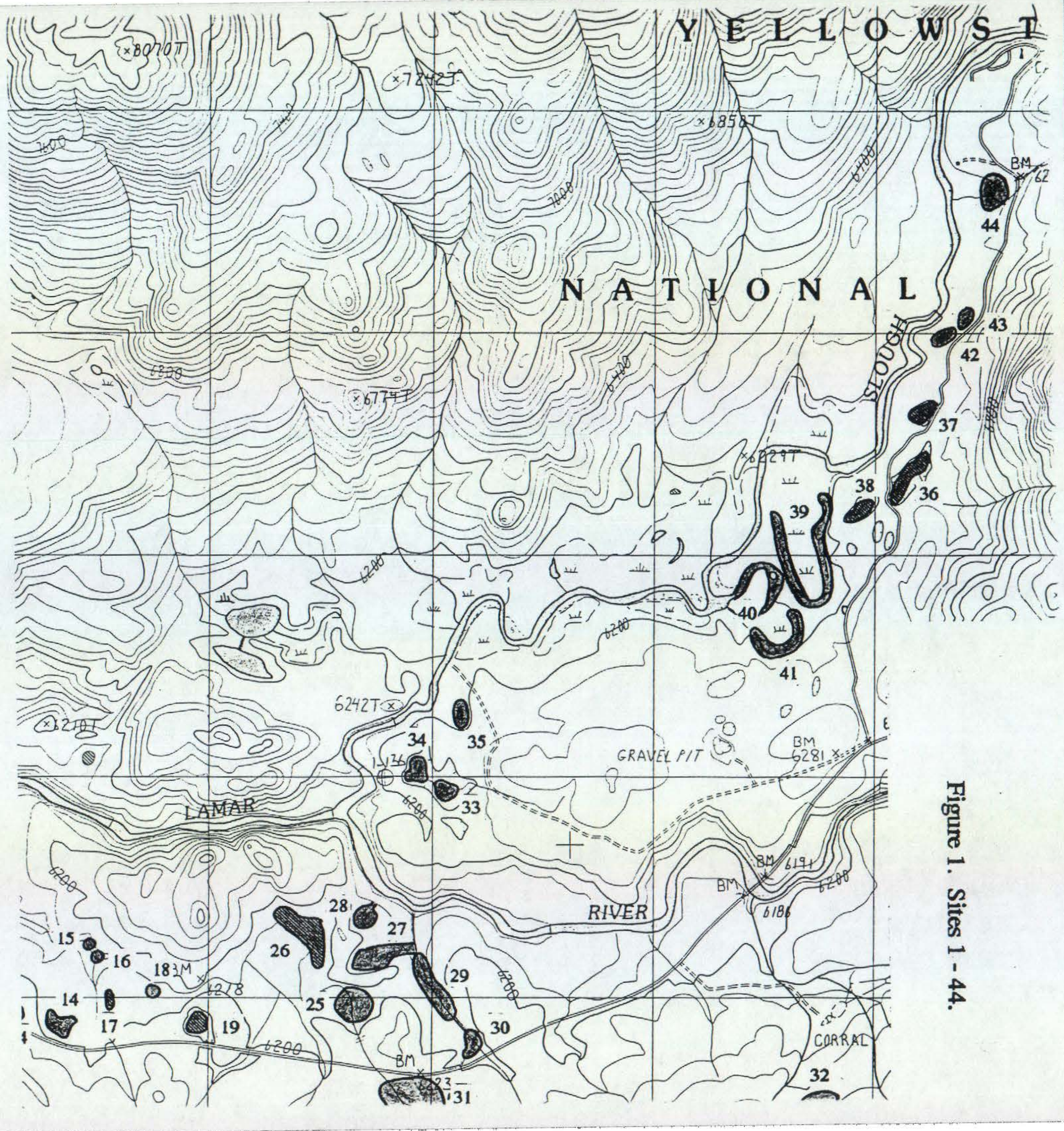
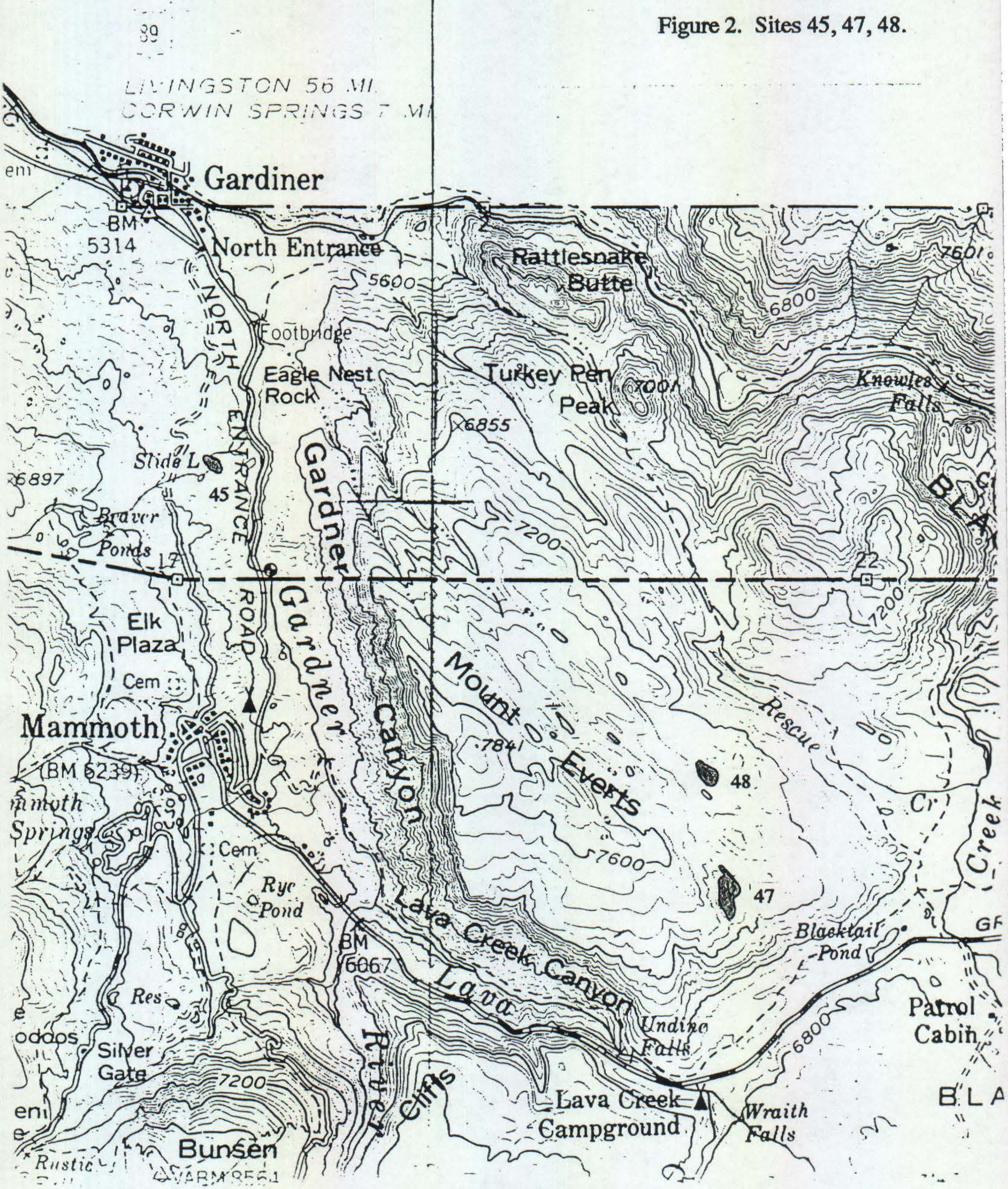


Figure 1. Sites 1 - 44.

Figure 2. Sites 45, 47, 48.



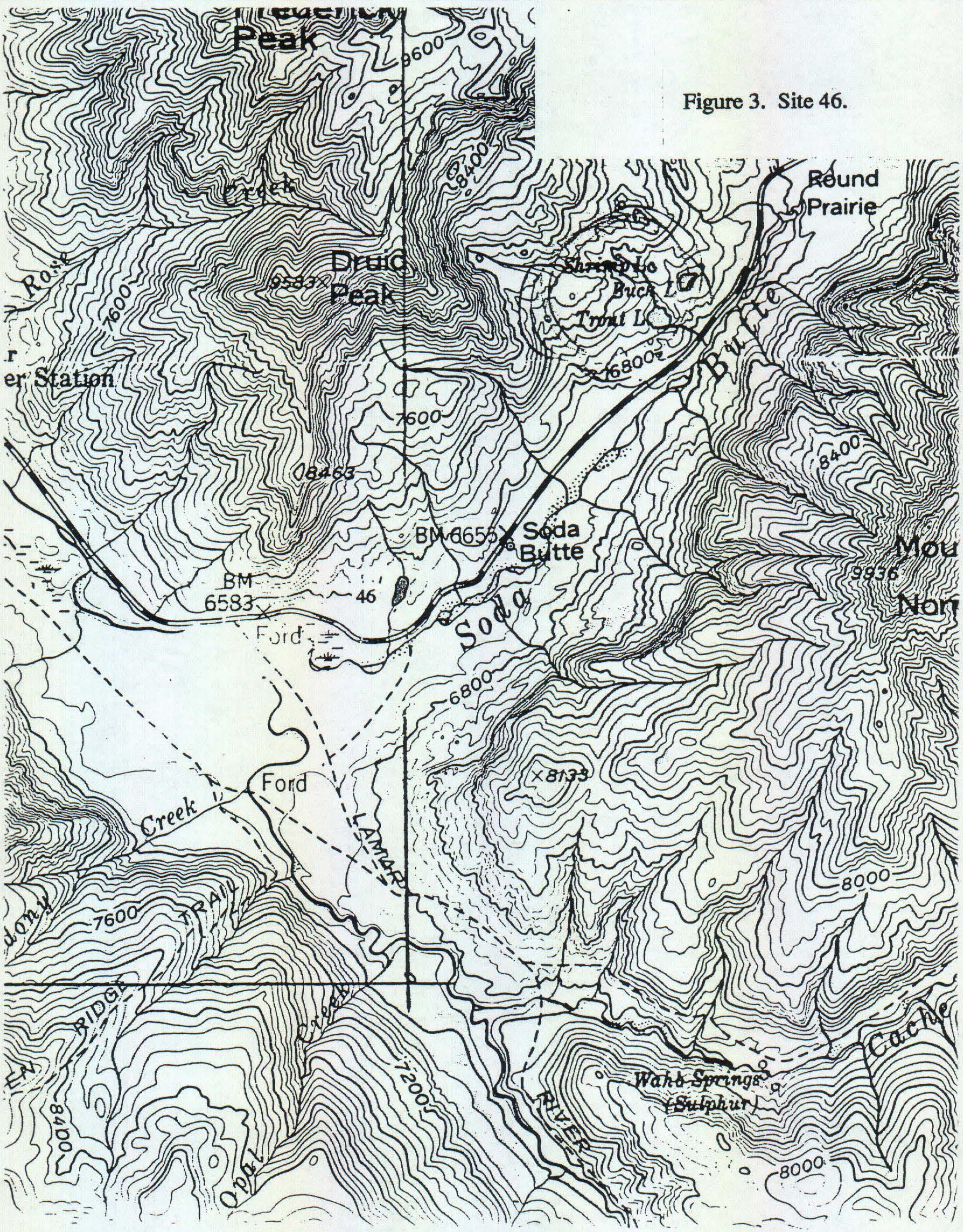


Figure 3. Site 46.